Your Laboratory Reports

The results of all your experiments should be submitted as laboratory reports. Usually, these will not be very LONG — a few pages is typical — but they DO have to contain some specific sections. Those are described below.

> ***The title*** of the exercise, your ***name***, and the ***date*** the report is submitted are three obvious but necessary things.
>
> ***A description of your equipment and observations*** comes next. This should include a brief summary of the purpose of the exercise, details about the equipment and how it was constructed, when and how observations were taken (and of what objects), the variables and controls, and what kinds of calculations (when applicable) were needed to get further results. [Do NOT present specific data here; just convey a general idea if how you did the exercise.]
>
> ***Data and results*** should follow. These can be in table and/or graphical form; for some exercises, drawings and specific information about location, weather conditions, time of observation, etc., will be needed. An important part of your results will be evaluating their level of UNCERTAINTY, and assigning some sort of number value like an average deviation or σ when appropriate. Even when a number value cannot be found, you should have a good idea where the greatest difficulties in obtaining accurate information were originating in the exercise (were errors of measurement mostly to blame? was the observing location too brightly lighted? was bad weather the main concern?).
>
> Your ***conclusions*** should complete the report. What concepts or relationships were demonstrated to you through the exercise? In what way(s) could the exercise be made more accurate or of more general application? [To say "use better equipment" is the "easy" way out. Be more creative than that! If you HAD to use the same equipment (there being none better), how would you proceed? Consider how making different kinds of observations or having a different experimental procedure might affect the experiment.]

Lab Report Checklist

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✔ **Title** of the experiment, your **name**, and the **date** the report is submitted

✔ **Description of equipment and observations**
- Brief summary of the purpose
- Details about the equipment and how it was constructed
- When/how the observations were taken (and of what objects)
- Identification of <u>variables</u> and <u>controls</u>
- What kinds of calculations (when applicable) were needed

✔ **Data and results**
- Tables and/or graphs, sometimes diagrams
- Specific information about location, weather, time of observation, etc.
- Evaluating the level of UNCERTAINTY
- Average deviation or σ when appropriate
- <u>Where</u> the greatest difficulties in obtaining accurate information originated

✔ **Conclusions**
- What concepts or relationships were demonstrated to you?
- How could the exercise be made more <u>accurate</u> or more <u>general</u>?

Sample Lab Report

<u>Estimating the Number of Stars Visible to the Naked Eye</u>
Celia K. Smith
September 23, 2002

<u>Equipment and Observations</u>: The purposes of this exercise were (1) to estimate the number of stars visible to the eye by taking samples around the sky, and (2) to investigate how the presence of the Moon in the sky would affect this number.

I looked through a paper-towel tube whose diameter and length I measured with a millimeter ruler. I observed on two different evenings from the University campus, in the student parking lot which did not have much bright lighting nearby. Observations on both nights started around 8:00 p.m. The dates were September 8, a clear night with no Moon; and September 20, also a clear night with a nearly full Moon. On each night, I chose ten different sky directions to measure: some high, some near the horizon but none right next to the Full Moon on the second night. From my numbers, I calculated an average value for each night and also a standard deviation. Then the total number of stars in a hemisphere of the sky on each night was computed from

$$N = (8L^2 / D^2) \times \text{(average number of stars)}$$

and the uncertainty in that number is

$$\text{Uncertainty} = (8L^2 / D^2) \times \text{(standard deviation)}$$

As controls in this experiment, I used the same paper-towel tube each night, observed on nights when the sky seemed to be clear, observed in ten different directions each time, and observed from the same location at about the same time each night. An independent variable in the experiment was the Moon's phase. A dependent variable was the number of stars seen on each night, which depended on the Moon's phase and could also depend on where I was aiming the paper towel tube.

<u>Data and Results.</u> I measured the dimensions of the paper-towel tube as $L = 298.1$ mm and $D = 43.9$ mm (averages of several measurements), so $8L^2 / D^2 = 369$. The table below shows the numbers of stars counted in each of the ten areas I chose, on the two different nights.

(September 8)		(September 20)	
Area	# of Stars	Area	# of Stars
1	10	1	1
2	12	2	4
3	15	3	3
4	6	4	1
5	8	5	5
6	11	6	0
7	9	7	4
8	10	8	6
9	13	9	5
10	7	10	8

Average = 10.1
Std.deviation = ± 2.6

N = 369 x 10.1 = 3730 stars
Uncertainty = ± 959 stars

Average = 3.7
Std. deviation = ± 2.4

N = 369 x 3.7 = 1370 stars
Uncertainty = ± 886 stars

Conclusions. In this experiment, I learned how a very large number of stars can be estimated by taking samples. I learned that on a dark, moonless night a person might be able to see several thousand stars at any time. The Moon, however, greatly drops the total number of visible stars (from 3730 to 1370) by lighting up the sky and making stars harder to see.

If I were to do this experiment over, I would take more samples of the sky, in various directions and at different elevations, to get a more accurate average number of stars. I would also see how the total number of stars depends on the Moon's phase at other phases besides Full. The paper towel tube had kind of a narrow view; the experiment could be repeated with a bigger tube, which would also let me count more stars.